tile, and in about a minute from the first touch of the Newt a strong flow of clear saliva. This was accompanied by much foam and violent spasmodic action, approaching convulsions, but entirely confined to the mouth itself.

The experiment was immediately followed by headache lasting for some hours, general discomfort of the system, and half an hour after by slight shivering fits. It was not intended that any of the poison should be swallowed, but such may have been the case to a slight degree; and none of the remedies (similarly intended merely to be held in the mouth), such as dilute ammonia, had any effect in removing the discomfort, till, about an hour after the experiment, swallowing a few spoonfuls of cream at once allayed much of the local irritation and with it the general discomfort of the system.

These observations appear to show the presence of a principle in the exudation of the Tritons which, whilst to a certain extent painful when applied to external injuries, is sufficiently powerful to cause serious disturbance by its physical effects on such of the sensitive internal surfaces as it may be allowed in ordinary circumstances to reach, and which, if acting with corresponding effect on more important organs, might, if swallowed, be probably dangerous, almost certainly exceedingly painful, in its action on the system.

To the Tritons themselves the exudation appears to act as a protection perfectly adapted to their needs as a defence against such enemies as they have most to fear from in their natural state: the spasmodic effect on the jaws, which would almost immediately ensure the Triton being dropped from the mouth of the attacking animal, joined to the temporary local pain and great discomfort, would (as far as experiment shows) be quite sufficient to distract attention from the reptile till it had time to conceal itself; and the effect as noticed by a casual passer-by would fully justify the common prejudice against the reptile, though harmless and inoffensive in its ordinary state.

On Diversity of Evolution under one set of External Conditions.

By Rev. JOHN T. GULICK.

[Read November 21, 1872.]

The terms "Natural Selection" and "Survival of the Fittest" present different phases of a law which can act only where there

is variation. The words in which the law is expressed imply that there are variations which may be accumulated in different proportions according to the differing demands of external conditions.

What, then, is the effect of these variations when the external conditions remain the same? Or can it be shown that there is no change in organisms that is not the result of change in external conditions? Again, if the initiation of change in the organism is through change in the "Environment," by what law is the cessation of change determined? If change continues in the organism long after the essential conditions of the "Environment" have become stationary, how do we know that it is not perpetual? Does the change, whether transitory or continuous, expend itself in producing from each species placed in the new "Environment" just one new species completely fitted to the conditions? or may it produce from one stock many that are equally fitted? If the latter, what is the law or condition that determines their number, their affinities, and the size and position of their respective areas, as related to each other and to the whole available area?

Facts throwing Light on the Subject.

I believe that in the relations of species to each other as distributed in nature, we shall find light on the subject. I call attention at this time to the variation and distribution of terrestrial mollusks, more especially those found on the Sandwich Islands; but similar facts are not wanting elsewhere.

The land-shells of the Sandwich Islands not only differ in species from those of other countries, but they belong, for the most part, to a group of genera found nowhere else. These are the *Achatinellinæ*, of which there are seven arboreal genera (*Achatinella, Bulimella, Helicterella, Laminella, Partulina, Newcombia,* and *Auriculella*), and three ground-genera (*Carelia, Amastra,* and *Leptachatina*).

Some of these genera are confined, in their distribution, to a single island. The average range of each species is five or six miles, while some are restricted to but one or two square miles, and only a very few have the range of a whole island.

The forest-region that covers one of the mountain-ranges of Oahu is about forty miles in length and five or six miles in breadth. This small territory furnishes about 175 species, represented by 700 or 800 varieties. The fall of rain on the north-

east side of the mountain is somewhat heavier than on the opposite side, and the higher ridges of the mountains are cooler than the valleys; but the valleys on one side of the range have a climate the same in every respect. The vegetation in the valleys differs somewhat from that on the ridges; but the vegetation of the different valleys is much the same; the birds, insects, and larger animals are the same. Though, as far as we can observe, the conditions are the same in the valleys on one side of the range, each has a molluscan fauna differing in some degree from that of any other. We frequently find a genus represented in several successive valleys by allied species, sometimes feeding on the same, sometimes on different plants. In every such case, the valleys that are nearest to each other furnish the most nearly allied forms; and a full set of the varieties of each species presents a minute gradation of forms between the more divergent types found in the more widely separated localities.

No theory is satisfactory that does not account, 1st, for their being distributed according to their affinities in adjoining areas more or less distinctly defined, and, 2nd, for their being restricted to very small areas.

External Conditions not the Cause.

I think the evolution of these different forms cannot be attributed to difference in their external conditions:—

1st. Because in different valleys, on the same side of the mountain, where food, climate, and enemies are the same, there is still a difference in the species.

2nd. Because we find no greater difference in the species when we pass from the more rainy to the drier side, than when we compare the forms from valleys on the same side of the mountain, separated by an equal distance.

3rd. Because if, failing to find a reason in the more manifest conditions, we attribute the difference in the species to occult influences, such as magnetic currents, we must suppose that there are important differences in these hidden conditions for each successive mile, and that their power at the Sandwich Islands is a thousand times greater than in most countries.

Separation and Variation Correlative Factors in the Evolution of Species.

If we would account for the difference and for the limited distribution of these allied forms on the hypothesis of Evolution

from one original species, it seems to me necessary to suppose two conditions, both of which relate to the state of the species—namely, Separation and Variation. I regard Separation as a condition of the species and not of surrounding nature, because it is a state of division in the stock which does not necessarily imply any external barriers, or even the occupation of separate districts. This may be illustrated by the separation between the castes of India or between different genera occupying the same locality.

To state the conditions more fully:—

1st. We must suppose that they possess or have possessed an inherent tendency to variation, so strong that all that is necessary to secure a divergence of types in the descendants of one stock is to prevent, through a series of generations, their intermingling with each other to any great degree. This supposition is not at variance, but rather in accordance, with facts that are observed in analogous cases in the history of man and of domestic animals of one original stock, that are kept entirely apart. But this condition alone would not be enough to account for the species of *Achatinellinæ* being confined to areas so much smaller than usual; for if this tendency has produced such results in the distribution of one family, why does it not in all?

Migration and Variation opposing Factors in the Limitation of Areas.

2nd. To account, therefore, for the small areas, we must further suppose that, as compared with other families, there is a disproportion between the tendency to variation and the tendency and opportunities to migrate. Either the tendency to variation in this family is very much greater than usual, or their tendency to migrate is weaker and their opportunities fewer than usual. According to *à priori* reasoning, the areas occupied must vary directly as the tendency, power, and opportunities for migrating, but inversely as the tendency to variation.

If the amount of migration is greatly expanded in proportion to the tendency to variation, the areas must be expanded; if, on the other hand, the tendency to variation is expanded as compared with the amount and extent of migration, the areas occupied by the different species must be correspondingly contracted.

If the power of migrating and the opportunities for being transported are very limited in any family of creatures, we may expect

that the areas occupied by the different species and varieties of that family will be more restricted than the areas occupied by the species of other families that have greater opportunities for migrating but the same tendency to variation. When we find that in Europe and North America nearly every species of *Helix* occupies an area many thousand times as large as the area occupied by any *Achatinella*, we naturally ask whether the difference can be accounted for by circumstances that limit the dispersion of the latter, or whether the results are to be attributed to a stronger tendency to variation. It is evident that to the forest species, that live on trees found chiefly in the valleys, the mountain-ridges separating the valleys must be partial barriers; but the valleys cannot be barriers to the species occupying the ridges, for the ridges rising between the valleys are all spurs from the one central range that forms the backbone of the island. In accordance with these facts we find that the distances over which the ridge species are distributed are usually somewhat greater than those reached by the valley species. But even the ridge species are limited in their distribution to very small areas. Few have a range of territory more than six or eight miles in length and three or four miles in breadth; and many are restricted to half that area. Though some of the groups of species are found both in the valleys and on the ridges, so that no barriers intervene to break the continuity of their intercourse, we still find them distributed over small areas, and these areas again divided amongst subordinate varieties. The streams that flow through these valleys cannot serve in carrying the shells from one valley to another; but the separation from this cause can be no greater than that which is experienced by mollusks inhabiting mountain-valleys in other countries. It therefore appears that the limited range of the species of this family receives but slight explanation from the nature of the country. Neither can we suppose that the power of locomotion in this family is so immeasurably below that possessed by the *Helices* of Europe and America, and by the *Achatinæ* of Africa, as to account for the excessive disproportion in the areas occupied, as well as in the amount of divergence between the types found in any locality and those found at given distances. In Africa some of the species of *Achatina* have a range of more than a thousand miles, while on the island of Oahu the most widely diffused species of the arboreal genus *Achatinella* is restricted to about ten miles, and the utmost limit gained by any

species of the ground-genus *Amastra* is about twenty miles. Again, the difference of type is quite as great between the species of *Achatinella* found in the mountains near the eastern end of Oahu and those found forty miles distant, on the other end of the same range of mountains, as the difference between the species of *Achatina* found in Sierra Leone and those in the region of Port Natal, nearly four thousand miles distant.

The birds that prey upon these snails are probably few; but the forests are populous with fruit- and nectar-feeding birds, that might be supposed to give as effectual means of transportation as could be given by any. The number of species represented by these birds is no doubt less than would in most cases be found in an equal extent of continental forest; but the number of individuals is probably greater than the average number inhabiting equal areas in other parts of the world.

If we find no reason for attributing the small areas occupied by these species to deficient means of transportation, may we not believe that rapidity of variation has had influence in determining the result?

Stability of Type as affected by Cultivation.

It is known that there is a great difference in the stability of type in different species of plants and animals that have been subjected to cultivation. One produces striking varieties in a single generation; another requires careful selection of certain characters for many generations before well-marked varieties can be secured. We also know that continued cultivation will, in many instances, break down the stability of type in a species that, in the first place, adhered with great persistency to one form. It often happens that when the stability has once been disturbed, a wide range of variation may afterwards be obtained with comparative rapidity.

Is it not possible that similar changes may sometimes take place in species in their wild state? Two important elements of the cultivation which tends to develop varieties are the removal of competitors and enemies, and the abundant supply of nourishment; but both these conditions may sometimes be furnished by nature without the intervention of man.

The Natural Selection that prevents Variation.

The more severe the competition the more rigidly does Natural Selection adhere to the one form that is best suited to meet that

competition, or, according to the language in which Professor Owen has stated the doctrine, the more certainly does the "Battle of Life" extinguish all variations from that one form. When a species is subjected to severe competition of the same kind for countless generations, we may well believe that it gains a stability of type that is not found in one that has during the same time been, either comparatively free from competition, or under the influence of a succession of different competitors and enemies*.

Stability of Type in Island Fauna may be impaired :—

1*st. By Freedom from the Competition that limits Variation.*—We can see that when animal life commences upon an island where vegetation has already become abundant, the first species that appears on the arena, unless immediately followed by other creatures capable of being either friends or foes, will enjoy for a time complete freedom from competition. If the vegetation is suited, it will also have an abundance of food. Under these circumstances every variation that occurs, unless decidedly malformed, will have a chance of living and exerting an influence upon the final result.

2*nd. By Competition accelerating Variation.*—If the introduction of competitive animals is long delayed, the first struggle for life will occur between the members of the one stock. But competition of this kind does not tend to prevent variation, but rather to accelerate it, by driving portions of the race into new spheres. Supposing the animals first inhabiting the island to be a species of arboreal mollusks, there would soon be an excess of occupants on the trees best suited to them in the region where they first appeared. The portion of the population that would survive this exigency would, in the first place, be those that found sustenance on trees of other kinds. Some of these would either themselves, or through their descendants, reach localities where the trees are again found on which the stock commenced its career. Those that, in this way, returned to the original trees, would have acquired some new tendencies to variation through the ordeal through which they had passed; and those that remained upon the other kinds of trees would rapidly develop new characters: in either case, there would be no outside competition limiting them to one definite form. New forms of variation would

* The only terrestrial mollusks with which the *Achatinellinæ* have to compete are a few *Helices* much inferior in size, and not arboreal in their habits.

have an opportunity of being preserved. New shades of colour, for example, would not expose the owners to the attacks of enemies. Variations of shape, if not inconsistent with the pursuit of food, would be no disadvantage.

3rd. By continual Change in the Character of the Natural Selection.—Still further, we can see that when competition arises from the *gradual* introduction of animals, either friendly or hurtful to the first occupants, the character of the Natural Selection, to which they would thus be subjected would be continually changing; no one set of characters would have constant advantage through a long series of successive generations.

In these ways the persistence of form might be impaired, and the variability which we may believe exists in some degree in all organisms might be greatly increased beyond what is usually found. This tendency to comparatively rapid variation having been established, the evolution of species would be correspondingly rapid, and the areas of each proportionately limited.

Imaginary Case, illustrating Evolution without change in the External Conditions.

If a bird should carry a leaf bearing two individuals of some species and drop it a mile beyond the limits already reached by others of that species, they might there find the same trees to which they were accustomed, and multiply for some tens of years before the first scattering individuals from the slowly advancing wave of migration would reach them. They might, by this time, have increased to many thousands; and having been entirely separated from the original stock for a considerable number of generations, with a preexisting tendency to rapid variation, a certain variety of form and colour might have partially established itself amongst them. The arrival of a few individuals representing the old stock would, amongst the multitudes of the new variety, have no influence in bringing back the succeeding generations to the original form. The new characters would become from year to year more distinctly set. Owing to an intervening ridge acting as a partial barrier, the number of individuals of the original stock coming amongst them might be always restricted; and even if no such barrier existed, the individuals arriving from abroad could never be more than a very small number compared with those produced on the spot and possessing the local characteristics.

Changes produced by the Introduction of Enemies.

At this point one other inquiry naturally arises :—If the multitude of varieties and the restricted distribution of both varieties and species is in any degree due to freedom from severe competition, what would be the effect if, by degrees, many birds and insects, hostile to these snails, should find their way to the Sandwich Islands and become numerous in those mountain-regions? One of the first effects would naturally be the disappearance of many varieties and species by which the different forms of each genus are now so minutely gradationed together. Certain protective colours would be made to prevail, to the partial exclusion of some of the brilliant contrasts of colour. The same enemies being found in all the valleys of an island, the forms that proved to be best fitted to survive in one valley would have the advantage everywhere, and therefore gradually spread from valley to valley. The distribution of species and their separation from each other by distinct forms would thus become similar to what is found in the case of continental species.

The destruction of forests by the introduction of cattle and goats is now causing the extinction of some of the species.

Recapitulation and Conclusion.

A comparison of the distribution of island mollusks with the widely contrasted distribution of continental species, leads me to believe that the evolution of many different species may take place without any difference in the food, climate, or enemies that surround them. The rapidity of evolution or the time within which a certain amount of change is effected must depend upon the average amount of change in one direction in a single genetation, and the rapidity of succession in the generations. Ten thousand years would make but little difference in a species of cedar, in which the life of a single tree might count a third of that period. But in the case of some species of insects the same period might cover ten thousand generations; and though the change in each generation might be as imperceptible as in the cedar, the aggregate of change for the whole period might be very apparent.

We must also bear in mind, the Natural Selection arising from severe competition with species that have a wide range tends to prevent variation and give a wider diffusion to forms that would

otherwise be limited in their range and variable in their type. Natural Selection is as efficient in producing permanence of type in some cases as in accelerating variations in other cases.

If we suppose separation without a difference of external circumstances is a condition sufficient to ensure variation, it renders intelligible the fact that, in nearly allied forms on the same island, the degree of divergence in type is in proportion to the distance in space by which they are separated. The difference between two miles and ten miles makes no change in climate; but it is easy to believe that it is the measure of a corresponding difference in the time of separation. In forms that differ more essentially, the separation may have been as complete and as long-continued in the case of those which now inhabit one valley as in the case of those which are separated by the length of an island. When a wide degree of divergence has been established, hybridation would be precluded. We accordingly find that the difference between species of different genera or subgenera is in most instances equally great whether we take for comparison those from the same or from different valleys.

If, on the other hand, we suppose that a difference in the external conditions is necessary to the evolution of distinct forms, these and other similar facts remain unexplained.

Notes on *Keropia crassirostris*, Gml. ("Piopio").

By THOMAS H. POTTS, Esq., F.L.S.

[Read November 7, 1872.]

IN writing on the natural history of our birds, the bewailment of their lessened numbers has come to be a matter of course. The rapid settlement of the colony, in the case of the Thrush, has limited its range greatly; few birds have retreated with so much haste before the efforts of the cultivator.

Let us take a section of this island, say a hundred miles in width (including Banks's Peninsula) and stretching from the eastern to the western shore; this will afford some information as to its present habitat.

Within this given range at one time the Piopio might be found in any bushy place not too far from water, where belts of shrubs afforded shelter and abundance of seeds; ten years at least have passed since we heard of its occurrence in this neighbourhood